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ROAD ACCIDENT ANALYSIS AND PREVENTION IN NIGERIA: EXPERIMENTAL AND NUMERICAL APPROACHES

Peter Siyan, PhD[1], **Boboye Oyeyemi, PhD**[2] and **Olabode Agunbiade**[3*]

[1] Professor of Economics, University of Abuja, Abuja, Nigeria.

[2] Corps Marshall, Federal Road Safety Corps, Abuja, Nigeria.

[3] PhD Student in Economics, University of Abuja, Abuja, Nigeria.

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ABSTRACT

This paper empirically analysed road accident and its prevention in Nigeria. Data for road traffic crashes trend was sourced from Federal Road Safety Corps in Nigeria from 1960 - 2017. The data was tested for stationarity using Augmented Dickey Fuller (ADF) test, while the co-integration was conducted using Johansen's methodology. Least Square estimate was employed for the empirical analysis. The results show that there is long run equilibrium relationship between total number of casualties, total number of fatal cases and total number of minor cases of accidents in Nigeria. The results show that there is positive and significant relationship between fatal cases, severe cases and total number of casualties, while minor cases have negative and significant relationship with total number of casualties. The study therefore recommends that government should invest massively in road transportation infrastructure in order to repair dilapidated roads, expand narrow roads and construct new ones. Government should legislate and enforce installation of speed limit devices for all vehicles operating on Nigerian roads to reduce reckless speeding on the highways which will definitely reduce total number of accidents and casualties on Nigerian roads.

1.0 INTRODUCTION

The transport sector is an important component of the economy, impacting on development and welfare of the people and it is a major prerequisite for the development of any nation. (Rodrigue and Notteboom, 2009). According to the World Health Organisation (2009), road transportation provides benefits to nations and individuals by facilitating the movement of goods and people, thereby enabling increased access to jobs, economic markets,

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*** Corresponding Author:** Olabode Agunbiade, bodeagun@gmail.com

education, recreation and healthcare; which in turn have direct and indirect positive impacts on the health of populations.

However, despite these multiple advantages, vehicle crashes and road accidents have serious negative consequences on the social, political and economic development of any nation. Inefficient movement of people and goods reduces productivity, wastes energy, increases emissions, compromises safety and threatens the quality of life. Continued growth in population, employment and trade have led to the placement of increasing demands on road transportation system; thereby challenging the efficiency of road network.

According to the World Health Organisation (2010), nearly 1.3 million people die each year as a result of a road traffic collision; which translates to more than 3,000 deaths per day. Additionally, twenty to fifty million more people sustain non-fatal injuries from collisions, and these injuries are important causes of disabilities worldwide. The WHO Report went further to state that eighty percent of road traffic deaths occur in low- and middle-income countries, even though these countries have only about one-third of the world's registered vehicle fleet. Road traffic injuries are among the three leading causes of death for people between 5 and 44 years of age. This is, in part, a result of rapid increases in motorisation without sufficient improvement in road safety strategies and land use planning.

It has been estimated that Road Traffic Accidents or Crashes will be the 3rd leading cause of death worldwide by the year 2020 if preventive actions are not taken to curb it (World Health Organisation, 2010). While South-East Asia has the highest proportion of global road fatalities, the road traffic injury mortality rate is highest in Africa (28.3 per 100,000 population when corrected for under-reporting), compared with 11.0 in Europe (Peden, Scurfield & Sleet 2004). In low-income countries and regions – in Africa, Asia, the Caribbean and Latin America – the majority of road deaths are among pedestrians, passengers, cyclists, users of motorised two wheelers, and occupants of buses and minibuses (Nantulya & Reich, 2002). The leading casualties in most high-income countries, on the other hand, are among the occupants of cars. However, when it comes to comparative fatality rates (deaths for any measure of exposure) for all users in the traffic system, these regional differences disappear. Nearly everywhere, the risk of dying in a road crash is far higher for vulnerable road users – pedestrians, cyclists and motorcyclists – than for car occupants. (ETSC, 2003).

In addition to the statistics on death and injuries, highway-related crashes result in immeasurable pain and suffering and many billions of dollars in medical expenses and lost productivity. The enormity of the impact of highway safety on human societies has resulted in massive expenditures on safety-related countermeasures, laws governing highway use, and numerous regulations concerning the manufacturing of highway vehicles. The economic consequences of motor vehicle crashes have been estimated between 1% and 3% of the respective GNP of the world countries, reaching a total over $500 billion. Reducing road casualties and fatalities will reduce suffering; unlock growth and free resources for more productive use.

Murray & Lopez (1997) have estimated that this trend is set to deteriorate, with road-traffic accidents rising from being the 9th most common cause of death in 1990 to the third most common cause of death by 2020. Thus, road injuries were chosen as the focus for the World Health Day in 2004 by the World Health Organisation (World Health Organisation, 2004). Therefore, over the years, traffic accidents have become a major issue in transport policy management around the world.

In Nigeria, the genesis of road traffic accidents is intricately linked with road transport development in the country (Isa & Siyan, 2016). Nigeria recorded her first traffic accident in Lagos in 1906 (Oluduro, 1999). For more than half a century thereafter, accident rates in the country remained low due largely to low vehicular population (Ogunsanya, 2004). From the 1970s, following remarkable improvements in the national economic prosperity arising from the oil boom, the magnitude of the accident problem increased. However, whether at the global or national level, human and material resources vital for development process are destroyed in road crashes. According to estimates, by 2030, deaths from road traffic accidents (RTAs) will surpass cerebrovascular disease, tuberculosis, and HIV/AIDS in Nigeria. (Iyanda, 2018).

The situation in Nigeria has been exacerbated by the near absence of alternative modes of transportation as an estimated 90% of passengers and freight in Nigeria rely on the road network, with the attendant challenge of increased number and incidence of road traffic crashes (Sumaila, 2013). Of all the modes of transportation in Nigeria, road transport is the dominant means of transportation that accounts for more than 90 percent of the sub-sector's contribution to the Gross Domestic Product (Siyan, 2017). A trend analysis of fatal road accidents in Nigeria between from 1960 to date shows annual increases in the number of cases and casualties. To date, there have been a recorded total of 1,129,942 RTCs and 1,596,066 causalities during the 58-year period (Federal Road Safety Corps- Nigeria - FRSC, 2017).

The FRSC (2012) estimates that Nigeria ranked 127 out of 175 on country ranking based on the World Health Organisation's estimated road traffic fatality per 100,000 populations in 2011. In terms of assessment, the Road Safety Management system in Nigeria is still a far cry from what is should be. The increasing rate of road accidents in Nigeria attest to the fact that a lot still needs to be done to improve the situation.

Our main objective in this paper is to carry out an holistic review of road accidents in Nigeria and seek ways to drastically reduce their incidence. In the course of doing this, we will assess the possible causes of road accidents, review statistics on the various degrees of casualties (minor, serious and fatal) and empirically ascertain how they interrelate. We will thereafter draw our conclusion and make policy recommendations on how to improve the deteriorating situation.

2.0 REVIEW OF LITERATURE

The world's first road traffic death involving a motor vehicle was alleged to have occurred on 31 August, 1869, when Irish scientist, Mary Ward died after she fell out of her cousins' steam car and was run over by it (Fallon & O'Neill, 2005). Road Traffic Crashes (RTCs) or Road Traffic Accidents (RTAs) occur when a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction, such as a tree or utility pole (Bun, 2012). The Federal Road Safety Commission (FRSC) of Nigeria, defines a road traffic accident as a collision between one or more vehicles or a moving vehicle and a stationary vehicle/object or pedestrian resulting in death, injury or damage to the vehicle or loss of physical property (FRSC, 2014).

Schwela (2008) defined Road Traffic Crash (RTC) as an unexpected collision between two or more road users as occasioned by either deficiency in traffic management system,

human incapability, mechanical inefficiencies or poor environmental condition, often resulting in various degrees of injuries, loss of lives and damages to properties. He further classified the various road users as motorists, motorcyclists, bicyclists and tricyclists. Others are pedestrians and animals. This definition broadly explains all the elements of RTCs such as the principal actors known as the road users, the causatives factors which can either be human, mechanical or environmental and the resultant effects which include injuries, loss of lives and damages to properties.

Causes of RTCs can be fairly grouped as 'general' and 'specific'. According to Ansari, Akhdar, Mandoorah and Moutaery (2000), the general causes of RTCs include increase in number of vehicles and expansion of transport network, large national projects that require extension of existing road networks, and activities of foreigners with lesser understanding of the road systems. The specific causes include driver error, excess speed, poor cognisance of road signs and road conditions (Ansari, et al., 2000). According to Malik, Saleh and Wani (2017), causes of accidents are multifactor and random as they are not by chance, but a chain of events involving: road users, vehicle defects, road condition, road design, environmental and other sundry factors.

In general, causes of RTCs from most countries can be summarised to include driver behaviour, vehicle types (motorcycles to large trucks), roadway condition (design, capacity, pavement type), traffic characteristics (flow, speed, density, occupancy), and environmental factors like weather (Pepple & Adio, 2014). In assessing the Nigerian situation, Siyan (2017) categorised the causes of traffic accidents into three major areas: (i) Human factor, (ii) Technical or mechanical factor and (iii) Environmental factor. Still on the Nigerian condition, Akpoghomeh (2012) noted that out of the three categories, the human factors are said to be responsible for over 70 percent of all traffic crashes because the drivers' operational ability is very critical to the cause and prevention of traffic accidents.

There are three major types of RTCs - Fatal, Serious and Minor (Scottish Government, 2001):

(i) A fatal accident is an accident in which at least one person dies less than 30 days after the accident.

(ii) A serious accident is one which does not cause death less than 30 days after the accident, and which is in one (or more) of the following categories: (a) an injury for which a person is detained in the hospital as an in-patient, or (b) any of the following injuries (whether or not the person is detained in the hospital): fractures, concussion, internal injuries, severe cuts and lacerations, severe general shock requiring treatment or (c) any injury causing death 30 or more days after the accident.

(iii) A minor accident is one in which at least one person suffers "slight" injuries, but no-one is seriously injured, or fatally injured.

However, it is also possible that some of the differences in the statistics of "serious injuries" and "slight injuries" may be due to changes in administrative practices, which may have altered the proportion of accidents which is categorised as "serious" such as changes in hospitals' admission policies.

Accident costs, comprising both fatal and non-fatal damage costs, make up an important part of the external costs of traffic. Damage costs include a variety of expenses related to e.g., medical treatment, material and immaterial damage, legal assistance, law

enforcement, loss of time, etc. Some of these costs can be measured in monetary terms, as there is a market for these goods, while others may not, due to lack of trading opportunities. Furthermore, some of these costs are borne by society as a whole (i.e., the taxpayer), whereas others merely constitute a financial burden to the traffic participants involved in an accident.

In India, Economic Times of India (2018) has estimated that more than 150,000 people are killed each year in traffic accidents, which translates to about 400 fatalities a day and far higher than developed auto markets like the US, which in 2016 logged about 40,000 for the year. Also, in Kenya, for example, more than 75% of road traffic casualties are among economically productive young adults (Odero, Khayesi & Heda, 2003).

George, Athanasios and George (2016) investigated road accident severity per vehicle type in Greece. They noted that it was the first time that such macroscopic analysis of accident severity for different vehicle types was carried out in Greece. They utilised 59,316 recorded accidents, using mathematical models by applying lognormal regression. In those accidents, 107,679 injured persons were involved. They discovered that, good weather conditions and crashes during the night were found to be associated with increased accident severity. Concerning crash types, they were found significant in most models.

Singh, Sahni, Bilquees, Khan and Haq (2016) carried out a descriptive study in two tertiary health-care delivery institutes in Kashmir, India. The most common mode of accident observed in the study was collision which occurred 135 times (42.7%) followed by knocked down 95 times (30.1%) and falling down 35 times (11.1%). Overturning of the vehicle and run over were reported in equal number of RTAs 15 times (4.7%) whereas 9 times (2.8%) reported hitting an object as the mode of accident.

Gómez and Bocarejo (2015) sought to model traffic accidents in the Bus Rapid Transit (BRT) scheme in Bogota, Colombia for each station using 35 variables. After a selection process of generalised linear models and a neural network model, they were used to compare the results and the neural network model had better predictability indicators. This assisted them to develop a scenario analysis.

Santos-Reyes, Avalos-Bravo and Rodriguez-Rojas (2014) studied the BRT system installed in Mexico City, Mexico and discovered at least 425 accidents happened generating traffic disruption in the study period. The approach applied are two accident analysis techniques, both of them allow the user to do a probabilistic analysis with qualitative variables considering an accident in the Mexico City BRT system as an undesirable event. The immediate causes users, infrastructure, red lights, highways and avenues, bad design on the intersections and bad design on the turnovers of the buses, among others.

In their study of the Ghanaian situation, Agyemang, Abledu and Semevoh (2013) attempted to show statistical evidence of the relationship between road traffic accidents and population growth in order to ascertain additional information in contributing to previous researches that have emerged in dealing with this menace. Time series data on yearly road traffic accidents and population values for Ghana covering the period 1990 to 2012 was used. The result from the analysis shows three key findings: a systematic visible pattern of growth in both road traffic accidents and population over the period; evidence of statistical relationship between road traffic accidents and population growth in Ghana as given by the correlation coefficient (r) of 0.854, with a corresponding coefficient of determination (r-square) of 72.9% indicating that for the period under study based on the available data, population is able to account for 72.9% of the changes in accidents in Ghana.

Although Bangladesh is one of the least motorised countries in the world, it has, however, the worst road fatality rates in the Asia-Pacific region. According to official statistics, there were at least 48,631 fatalities and 25,437 injuries in 29,319 reported accidents during an eight-year study period: 1998-2005 (Anjuman, Hasanat-E-Rabbi, Siddiqui & Hoque, 2007). However, it is estimated that the actual fatalities could well be 10,000-12,000 each year. According to Ali and Tayfour (2012), road traffic accident (RTA) casualties in Sudan are among the major causes of death in the age group of 21 to 60, with 61% fatalities. The fatality rate of 35 per 10,000 vehicles is among the highest in the world despite the low car ownership of 1 vehicle to 100 persons.

For the Nigerian situation, Osayomi (2013) employed the stepwise multiple regression model to identify the most significant factors that influenced the observed spatial distribution of road traffic accidents. The study hypothesised that the regional variation in road traffic accidents are significantly affected by the level of economic development, traffic density, degree of urbanization, population size, and road infrastructure. Akpoghomeh (2012), reported that from 2008-2011, human causative factors accounted for 73% of traffic accidents in Nigeria, while technical factors accounted for 20% of the causes. Speed violation, dangerous driving and loss of control, contributed 60% of the human causative factors. His analysis was based on secondary data obtained from the FRSC and did not distinguish the causes according to types of vehicles or traffic characteristics.

Kareem, Oke and Lawal (2012) utilised data on casualties of road accidents in Nigeria which were statistically analysed and modelled for predicting fatality of the accidents. The results obtained showed that the fatalities of the road accidents have polynomial relationships with the population of the road users, or time. The highest annual accident fatality probability of 0.17 was obtained over the total population of the road users. The result from combined modelling of traffic population and time showed that the accident fatalities will rise in future, unless roads and drivers are well cultured.

Pai (2009) utilised UK national crash data from 1991 to 2004 to analyse the severity of two or more vehicle-crashes which have occurred at T-junctions involving at least one motorcycle. The researcher applied binary logistic regression and found that some factors which seem to increase severity are rider age (over 60 years old), high engine size, fine weather, right-of-way violation and involvement of heavy goods vehicle.

Valent, Schiava, Savonnito, Gallo, Brusaferro and Barbone (2002) applied logistic regression to evaluate the association of driver characteristics and accident severity in Italy. The results indicated that males are more likely to be engaged in fatal accidents and that car drivers are less likely to be fatally injured than killed than motorcyclists. In a similar vein, Chang and Wang (2006) carried out a road accident study in Taipei, Taiwan and argue that the most important factor that affected crash severity was the type of vehicle.

3.0 METHODOLOGY AND THEORETICAL FRAMEWORK

The Theoretical Framework for this study is premised on the Human-Capital Approach to losses occasioned by RTC. These are intangible losses, such as pain, sorrow, loss of quality of life, etc. as advocated by Mushkin and Collings (1959). The advantage of the Human Capital Approach over the Willingness To Pay (WTP) methodology is that it can measure human output or productivity, while WTP seeks to assess the trade-off between

wealth and risk (Mofadal & Kanitpong, 2016). In other words, Human Capital Approach deals with lifetime consumption and can efficiently achieve maximum national income objectives. Further, Alrukaibi, Alotaibi and Almutairi (2015) believe that the human capital method is quite commonly used by researchers, especially in developing countries.

3.1 Model Specification and Estimation Technique

The study employed ordinary least square (OLS) multiple regression analysis in estimating the specified model. Multiple regression analysis is a multivariate statistical technique utilised to examine the relationship between a single dependent variable and a set of independent variables. The objective of the multiple regression analysis is to use independent variables whose values are known, to predict the single dependent variable. The model is a modification of the empirical models of Murray and Lopez (1997); and Aworemi, Abdul-Azeez, and Olabode (2010).

The basic functional model in its general form is specified as follows:

$$TC = f(FC, SC, MC) \quad (3.1)$$

The model assumes an approximately linear relationship between the dependent variable and independent variables. A simple linear least square econometric form is specified, given the variables under consideration thus:

$$TC = \beta_0 + \beta_1 FC + \beta_2 SC + \beta_3 MC + U \quad (3.2)$$

Where:

TC = Total number of Casualties
FC = Total number of Fatal Cases
SC = Total number of Severe Cases
MC = Total number of Minor Cases
U = Error Term, which is assumed to be normally distributed with zero mean and constant variance
β_0 = constant term while $\beta 1$, $\beta 2$ and β_3, are parameters to be estimated.
Apriori Expectations: $\beta 1$, $\beta 2$ and $\beta_3 > 0$.

4.0 DISCUSSION OF RESULTS

All results to be analysed in this section are computed using Microfit 5.0 and Eviews 9.0 statistical software packages. The Augmented Dickey-Fuller test will be used to test for unit root. All the variables were regressed on trend and intercept to determine if they have trend. It was discovered that the four variables have trend and intercept, hence the unit root test involves trend and intercept.

4.1 Stationarity Result

Table – 1: *Unit Root Stationarity Result*

Variable	ADF Statistics	Critical Value	Stationary Status
TC	-6.753488	-2.606911(1%) -1.946764(5%) -1.613062(10%)	I(1)
FC	-9.612857	-2.606911(1%) -1.946764(5%) -1.613062(10%)	I(1)

SC	-11.61329	-2.606911(1%) -1.946764(5%) -1.613062(10%)	I(1)
MC	-10.57209	-2.606911(1%) -1.946764(5%) -1.613062(10%)	I(1)

Source: *Authors' Computation*

The critical values for rejection of hypothesis of unit root were from MacKinnon (1991) as reported in e-views 9.0.

The four variables (TC, FC, SC and MC) underwent unit root test using the Augmented Dickey-Fuller (ADF) test. As is the case most times, all the variables were found to be non-stationary at levels but all the variables were found to be stationary after first difference.

4.2 Co-Integration

Table – 2: *Johansen Co-integration Test*

Series: TC FC SC MC

Unrestricted Co-integration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.509864	74.33411	55.24578	0.0005
At most 1 *	0.333255	36.54130	35.01090	0.0340
At most 2	0.183857	15.05784	18.39771	0.1380
At most 3 *	0.077756	4.290094	3.841466	0.0383
Trace test indicates 5 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Source: *Authors' Computation*

The Table above shows there is long run relationship among three key the variables which are TC, FC and MC. The result shows that the three variables of the model (TC, FC and MC) converge in the long run thereby depicting the existence of long run relationship among them. The long run relationship exists at 5% level of significance according to the trace test statistics. However, SC is not co-integrated with the rest of the variables. Since there exist co-integrating relationships among the three key variables, there is long run co-existence among the variables.

4.3 Regression Result

Table – 3: *General Regression Result*

Independent Variables	Coefficient	Standard Error	t-Statistic	P-Value
Constant	1468.706	3925.120	0.374181	0.7097
FC	2.026810	0.587488	3.449958	0.00000
SC	3.647185	0.693264	5.260891	0.0011
MC	-1.612429	0.383748	-4.201791	0.0000

R^2	0.489824	**F-Statistic**	17.28194	0.0001
Adjusted R^2	0.461481	**D-W Statistic**	1.951771	

Source: *Author's Computation*

Dependent Variable: *TC*

4.4 Interpretation of Results

From the result in Table above, we can therefore infer that a unit increase in Total number of Fatal Cases (FC), on the average holding other independent variables constant, will lead to 2.026810 unit increase in Total number of Casualties (TC). This shows that FC has a positive impact on fatal cases with the impact being statistically significant going by the low probability value. This result fulfils apriori expectation. In the same vein, a unit increase in Total number of Severe Cases (SC) on the average holding other independent variables constant will lead to 3.647185 unit increases in Total number of Casualties. This shows that Total number of Severe Cases has a positive impact on Total number of Casualties with the impact being statistically significant going by the low probability value. This result fulfils apriori expectation. Also, a unit increase in Total number of Minor Cases (MC) on the average holding other independent variables constant will lead to 1.612429 unit decrease in Total number of Casualties. This shows that Total number of Minor Cases has a negative impact on Total number of Casualties but the negative impact is statistically significant going by the high probability value. This result does not conform with apriori expectation.

5.0 CONCLUSION AND POLICY RECOMMENDATIONS

The evidences from the analyses from this study revealed that, there exist both short-run and long-run relationships between total number of casualties and different cases of accidents which include fatal, severe and minor in Nigeria. This was confirmed by the positive relationships between fatal cases and severe cases which is also significant with total number of casualties. From the empirical analysis, it can be deduced that severe cases have more impact on total number of casualties than fatal cases. This can be confirmed by the total number of severe injuries that passengers have whenever there are accidents on Nigeria roads which can be attributed to bad road networks, reckless driving by drivers, over speeding, poor condition of vehicles, lack of driving skills among others.

There is an urgent need for government to develop adequate transportation system across the country which helps reducing the use of roads as major means of transportation and improving other means of transportation like rail, water, air, among others. This will indeed reduce total accident casualties and cost of accident in Nigeria. We therefore recommend that government should invest massively in transportation infrastructure to address the shortcomings in infrastructure provision in Nigeria in order to repair dilapidated roads, expand narrow roads and construct new roads in order reduce total accident casualties in Nigeria. There should be legalisation and enforcement of Speed Limit Devices on all vehicles operating on Nigeria roads to reduce reckless speeding on the highways which will definitely reduce total number of accidents and casualties on Nigerian roads. All Government road safety agencies should enforce a law that will discourage the use of what is known as "Tokunbo" tyres, which are imported vehicle tyres that have been used for more than five years in other countries.

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